

## Medication Use and Prescribing Considerations for Elderly Patients

Bradley R. Williams, PharmD, FASCP, CGP\*,  
Jiwon Kim, PharmD

*University of Southern California, School of Pharmacy, 1985 Zonal Avenue,  
Los Angeles, CA 90089-9121, USA*

The US Census Bureau [1] estimates that approximately 34.7 million people of at least 65 years of age and 4.25 million people of at least 85 years of age live in the United States. These figures represent 12.6% and 1.6%, respectively, of the total population. By the year 2030, the percentages are anticipated to be 19.9% and 2.4%. This increased longevity, however, does not necessarily imply good health. Almost 30% of adults aged 65 years and older rate their health status as fair or poor. More than 30% of people aged 65 to 74 and almost 45% of people aged 75 and above experience some form of disability [2]. Among adults aged 65 years and older, the most common chronic conditions are arthritis, hypertension, respiratory illnesses, heart disease, diabetes, stroke, and cancer [3]. One common characteristic of these conditions is the importance of pharmacotherapy in their successful management.

### Medication use by older adults

As would be expected from the prevalence of chronic disease in their population, older adults are heavy consumers of prescription medicines. According to estimates from the Medicare Current Beneficiary Survey, more than 70% of Medicare beneficiaries take at least one chronic medication, and nearly one third take at least three chronic medications. Almost 60% of community-dwelling elderly take at least three medicines [4]. Not unexpectedly, those who have more health problems take more drugs.

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\* Corresponding author.

E-mail address: [bradwill@hsc.usc.edu](mailto:bradwill@hsc.usc.edu) (B.R. Williams).

Cardiovascular drugs are taken by more than 58% of older adults and represent the most frequently prescribed drug class. Analgesics are taken by 28.3%, central nervous system drugs (anticonvulsants, antiemetics, muscle relaxants) are taken by 13.1%, and psychotherapeutic agents and respiratory-tract drugs are each taken by 18% of the elderly population [4].

Age-associated physiologic changes affect the way older adults respond to drugs. Changes in gastric acidity and gastrointestinal motility can slow drug absorption and delay the onset of action of drugs, such as analgesics. Increased body fat and decreased body water and serum albumin levels modify the distribution patterns and alter the duration of action or pharmacologic activity of several agents, including sedatives and anesthetics. The reduced activity of many hepatic enzyme systems and decreased renal function may increase the risk for drug interactions and slow the elimination of medications [5].

Several other factors cause changes in drug response. Geriatric patients often are more susceptible than younger adults to central nervous system depressants. Reduced parasympathetic nervous system activity increases the likelihood that anticholinergic adverse effects will occur; the resulting dry mouth may adversely affect oral health [6]. The decline in the density of beta-adrenergic receptors can affect the vasodilatory response in the elderly. Reduced cardiac output and decreased total body water, combined with changes in baroreflexes, predispose older adults to hypotension and orthostatic effects of diuretics and antihypertensive agents; this should be considered when positioning elderly patients in a dental chair [7].

### **Polymedicine and medication-related problems**

The risk that an adverse drug reaction or drug interaction will occur increases with the number of medications taken. The prevalence of medication use plus other factors predisposes older adults to medication-related problems (MRP). In addition to age-associated alterations in pharmacokinetics and pharmacodynamics, use of unnecessary or inappropriate medications and nonadherence to medication regimens contribute to the development of MRP. Age per se is probably not a factor for medication-related problems [8].

Polymedicine often is recognized as the use of more than a certain number of medications (eg, five or more). However, associating polymedicine only with the number of drugs taken can be misleading. An elderly patient who takes four drugs but who has only mild pain from osteoarthritis that is managed with acetaminophen may be exhibiting polymedicine. In contrast, a patient taking a total of eight medicines to treat diabetes mellitus, hypertension, hyperlipidemia, hypothyroidism, and rheumatoid arthritis may be living independently because of the use of multiple drugs. A more appropriate definition of polymedicine is the use of unnecessary medi-

cations, independent of the number of drugs taken. This definition directly links medication use to specific problems and allows for a better evaluation of a patient's drug regimen.

Several factors contribute to the development of polymedicine. The presence of multiple disease states often leads to the prescribing of several medications. The risk for adverse drug reactions or interactions increases with the number of medications, and the adverse reactions may then be treated with additional medications. A prescriber, unaware of drugs ordered by other clinicians, may prescribe a medication that duplicates or antagonizes the effect of a medicine the patient is already taking.

The use of medications that pose a high risk for adverse effects in older adults contributes to MRP. Potentially inappropriate medications are prescribed to more than one in five community-dwelling elderly people [9]. These are drugs that should be avoided in older adults because they either are ineffective, produce a high rate of adverse reactions, or are contraindicated in the presence of some diseases common among the elderly [10,11]. Examples of potentially inappropriate medications with relevance to dental practice are noted in Table 1. Prescription of potentially inappropriate medications to elderly patients has been estimated to occur during 4.45% to 7.8% of visits to physicians' offices in the United States [12,13]. Although there are no specific data on the likelihood of such practices occurring in dental offices, the figure may be quite similar.

Patients also contribute to MRP. Older adults are the most frequent consumers of nonprescription remedies and increasingly turn to alternative medicines to self-treat disease symptoms. Many older adults respond to advertising or rely on testimonials from friends or relatives to help them decide which product to purchase. In addition, direct-to-consumer advertising of prescription medications fuels the demand for products that are often new, expensive, and not well tested in the geriatric population. It is thus important that a medication history specifically include nonprescription and alternative medications to minimize the risks associated with self-treatment.

Polymedicine and nonadherence are frequently linked. Col et al [14] reported that 28% of admissions of older adults to a major medical center were due to medication-related problems. Adverse drug reactions were implicated in 60% of those admissions; nonadherence to medication regimens accounted for the remainder. Difficulty in recalling a medication regimen, multiple medications, multiple prescribers, female gender, moderate income, and the perception that medications were expensive were predictors for nonadherence. Fitten et al [15] identified diminished functional and cognitive capacities and increasing complexity of the medication regimen as factors predisposing elderly patients to nonadherence to medication regimens. The necessity of taking multiple daily doses also reduces adherence to a drug regimen [16].

Table 1  
Problematic or potentially inappropriate medications for older adults

Medication	Potential problem
Analgesics	
Meperidine	CNS toxicity with oral dosage forms
NSAIDs	High risk of CNS effects (indomethacin); caution in patients with cardiovascular problems
Pentazocine	High risk of CNS adverse effects, ceiling analgesic effect
Propoxyphene (and combination)	Narcotic adverse effects; no better analgesia than acetaminophen
Psychotropic agents	
Benzodiazepines	Long-acting agents have prolonged effects; increased risk for falls and confusion
Phenothiazine antipsychotics	Sedation, dry mouth, dizziness, orthostatic hypotension, pseudoparkinsonism
Tricyclic antidepressants	Sedation, dry mouth, dizziness, orthostatic hypotension
Antihistamines	
Sedating agents	Chlorpheniramine, diphenhydramine, hydroxyzine, and promethazine have high anticholinergic properties.
Antispasmodics	
Bowel antispasmodics	Dry mouth, reduced gastrointestinal motility, changes in swallowing
Urinary bladder antispasmodics	Dry mouth, changes in swallowing

*Abbreviations:* CNS, central nervous system; NSAIDs, nonsteroidal anti-inflammatory drugs.

**The most frequently prescribed medications in the elderly**

The most frequently prescribed medications that may have an impact on dental treatment in older patients include cardiovascular drugs, anti-inflammatory agents, gastrointestinal agents, psychotropic agents, and endocrine agents [17]. Table 2 lists the most frequently prescribed medications in the elderly and the precautions dentists must take when delivering dental care to this patient population.

*Cardiovascular drugs*

Cardiovascular disease is the leading cause of death among people 65 years and older in the United States and one of the most common chronic disorders among elderly Americans [3]. Medications used to treat heart disease and other cardiovascular disorders include angiotensin-converting enzyme inhibitors (ACEIs), calcium channel blockers, beta-blockers, and diuretics and digoxin [18]. Warfarin is commonly used in geriatric patients with atrial fibrillation [19].

ACEIs are first-line agents for treating hypertension and heart failure in older patients [20,21]. ACEIs also are considered agents of choice in patients

Table 2

Most frequently prescribed medications and dental management considerations in the elderly

Drugs	Dental management considerations
<b>Cardiovascular drugs</b>	
Angiotensin-converting enzyme inhibitors	Angioedema, orthostatic hypotension, xerostomia
Calcium channel blockers	Orthostatic hypotension, xerostomia, gingival hyperplasia, drug interactions (erythromycin derivatives, bupivacaine, mepivacaine)
Beta blockers	Orthostatic hypotension, use of vasoconstrictors, xerostomia
Diuretics	Orthostatic hypotension, xerostomia
Digoxin	Orthostatic hypotension, drug interactions, xerostomia
Warfarin	Drug interactions, bleeding
<b>Nonsteroidal anti-inflammatory drugs</b>	
Nonspecific agents	Platelet inhibition, stomatitis
Cyclo-oxygenase-2 inhibitors	Platelet inhibition, stomatitis
<b>Gastrointestinal agents</b>	
Histamine-2 receptor antagonists	Xerostomia, regurgitation, altered taste, enamel erosion that can lead to pulpal disease
Proton pump inhibitors	Regurgitation, altered taste, pulpal disease, enamel erosion that can lead to pulpal disease
<b>Psychotropic agents</b>	
Benzodiazepines	Sedation, cognitive impairment, dry mouth
Selective serotonin reuptake inhibitors	Dizziness, dry mouth, taste changes

with diabetes. The most common side effects of ACEIs are dry cough, orthostatic hypotension, and dizziness. Angioedema is a rare but severe adverse effect associated with ACEIs [22].

Calcium channel blockers, such as amlodipine, nifedipine, diltiazem, and verapamil, also are used frequently for treatment of hypertension and chronic stable angina in older adults. Amlodipine and other long-acting dihydropyridine calcium channel blockers are considered the preferred treatment for the isolated systolic hypertension commonly seen in the elderly [23]. Common adverse effects of calcium channel blockers are flushing, peripheral edema, headache, and oral side effects, including dry mouth and gingival hyperplasia [24].

Diuretics are commonly prescribed to older patients for the control of hypertension and edema. Thiazides (eg, hydrochlorothiazide) are used primarily as first-line agents for hypertension, and the loop diuretics (eg, furosemide) are used to alleviate edema in congestive heart failure (CHF). Dehydration and electrolyte imbalances are common side effects of diuretics [18].

Digoxin is used in the management of atrial fibrillation and CHF but is associated with a narrow therapeutic index and can lead to digitalis toxicity, especially in elderly patients with compromised renal function. Symptoms of digoxin toxicity include nausea, confusion, and cardiac arrhythmias [18].

Warfarin is used to prevent stroke and other thromboembolic events in atrial fibrillation, which affects about 5% of the geriatric population. Several factors put elderly patients at increased risk for bleeding with warfarin therapy, including slower metabolic clearance of drugs, multiple chronic illnesses, and drug interactions [25]. Therefore, laboratory assessment of bleeding risk should be obtained before performing a dental procedure that will induce bleeding.

Antihypertensive agents, including diuretics, have been associated with xerostomia [26], which may induce oral pain, taste changes, and increased risk for oral infections such as gingivitis, oral candidiasis, and multiple dental caries. A thorough medication review and comprehensive clinical examination are essential to proper management of drug-induced xerostomia in elderly patients who are particularly at risk because of chronic multiple drug therapy. Along with palliative measures and aggressive caries prevention methods, effective management of xerostomia may require a physician consultation for appropriate drug dosing regimen or therapeutic drug substitution in older individuals. In patients taking ACEIs, complete extraoral and intraoral examination should be conducted to rule out the possibility of ACEI-induced angioedema, because several cases of late-onset ACEI-associated angioedema have been reported [27].

All antihypertensive agents can cause hypotension, and dentists should take care to avoid imbalance and dizziness that may precipitate falls in older patients. Dentists should allow patients to sit up slowly from a reclined position and remain seated for a few minutes before leaving the chair. In addition, a thorough medical and drug history may help to identify patients with uncontrolled hypertension and make it possible to avoid cerebrovascular accidents or myocardial infarction in these patients by taking blood pressure readings at each appointment. Local anesthetics with vasoconstrictors should be used with caution; repeated injections of epinephrine over a short period of time can increase blood pressure in these patients. Several antibiotics commonly prescribed by dentists, including erythromycin and tetracycline, can increase the anticoagulant effect of warfarin and potentially cause severe bleeding in patients on warfarin therapy [28]. Drug interactions with warfarin should be thoroughly assessed before one prescribes new drugs for dental treatment (Table 3).

### *Nonsteroidal anti-inflammatory drugs*

Nonsteroidal anti-inflammatory drugs (NSAIDs) comprise a large group of compounds that provide analgesic, anti-inflammatory, and antipyretic effects. Older adults frequently are prescribed NSAIDs for osteoarthritis,

Table 3

Warfarin drug interactions with commonly prescribed medications in dental treatment

Interacting drug	Adverse effect
Erythromycin	↑ anticoagulation and ↑ risk for bleeding
Tetracycline	↑ anticoagulation and ↑ risk for bleeding
Metronidazole	↑ anticoagulation and ↑ risk for bleeding
Chloral hydrate	↑ anticoagulation and ↑ risk for bleeding
Barbiturates	↓ anticoagulation and ↑ risk for thromboembolism

the most common cause of disability in people over 75 years of age and the most common cause of immobility in older adults [29]. NSAIDs are effective in the management of pain and inflammation in geriatric patients who experience inadequate pain relief from acetaminophen. An estimated 50% of all NSAIDs produced are consumed by older adults seeking relief from osteoarthritis pain [30]. NSAIDs, however, cause several adverse effects, including gastrointestinal (GI) bleeding, impaired renal function, and platelet inhibition. The risk of serious GI complications with NSAIDs therapy increases with advanced age [31]. Advanced age is also a major risk factor for NSAID-induced renal toxicity, which often presents as sodium and water retention and an increased risk for hypertension [32]. When treating patients who are receiving chronic NSAID therapy, dentists should be aware of platelet inhibition effects of NSAIDs and take precautions for bleeding complications in surgical cases. When prescribing analgesics for pain and inflammation, one should conduct a thorough medication history to avoid therapeutic duplication of anti-inflammatory agents.

### *Gastrointestinal agents*

Both histamine-2 receptor antagonists ( $H_2$  blockers) and proton pump inhibitors (PPIs) are commonly prescribed in the elderly for management of heartburn associated with gastroesophageal reflux disease (GERD) and peptic ulcer disease (PUD). They also are frequently used by older patients on chronic NSAID therapy to prevent GI toxicities. All currently marketed  $H_2$  blockers (cimetidine, famotidine, nizatidine, ranitidine) are available by prescription and as reduced-strength over-the-counter (OTC) products; many older adults self-treat GI symptoms with these agents. All  $H_2$  blockers are eliminated renally, and side effects associated with the accumulation of  $H_2$  blockers may be present in older adults who have renal impairment. Adverse effects associated with cimetidine accumulation include confusion, delirium, and hallucinations [33]. Cimetidine also interacts with several drugs that can lead to toxic effects. Plasma concentrations of theophylline, warfarin, and quinidine can increase as a result of metabolic inhibition by cimetidine, causing severe toxicity because of the narrow therapeutic range of these medications. Although the low doses approved for OTC labeling are unlikely to cause serious drug interactions, many older patients with

compromised renal function may experience reduced clearance of cimetidine, and chronic drug therapy can lead to drug accumulation and the potential for adverse events.

Omeprazole is the only PPI available without a prescription. It is indicated for frequent heartburn and is approved for a 14-day course of therapy [34]. Esomeprazole, lansoprazole, pantoprazole, rabeprazole, and higher-dose omeprazole are available by prescription. PPIs are potent acid reducers with well-documented safety and efficacy for GERD and PUD [35]. In dental patients with chronic H<sub>2</sub> blockers or PPI therapy, dentists should examine the possibility of undercontrolled reflux disorders. These can present with taste changes and enamel erosion, which, if sufficiently severe, can lead to pulpal disease. In addition, a semisupine position on the dental chair should be considered for these patients to avert regurgitation.

### *Psychotropic agents*

Sedatives and anxiolytics are widely used in older patients [4]. The use of benzodiazepines is estimated to be as high as 40% in adults greater than 65 years of age [36]. Benzodiazepines undergo hepatic degradation before being cleared from the body, and age-associated changes in pharmacokinetics and pharmacodynamics predispose geriatric patients to a greater risk for adverse effects, such as excessive sedation [37], cognitive impairment, and falls [38].

Depression is the most common mental illness among older adults, occurring in about 15% of the geriatric population [39]. Among several available and equally efficacious classes of antidepressants, selective serotonin reuptake inhibitors (SSRIs) are the best tolerated in the elderly and the most widely prescribed antidepressants in this population [40]. Currently marketed SSRIs are fluoxetine, citalopram, escitalopram, paroxetine, and sertraline. Common side effects associated with SSRIs are dizziness, insomnia, and gastric distress. Because these central nervous system (CNS) agents are well known to cause dizziness and may cause sedation, precautions should be taken when providing them to elderly dental patients to minimize the potential for falls and fractures.

### *Endocrine agents*

Over 20% of older individuals are diagnosed with diabetes [41], and several drugs are used to control blood glucose in these patients. Sulfonylureas, such as glipizide and glyburide, are often used as first-line agents for newly diagnosed diabetes and are commonly prescribed in older diabetics. Hypoglycemia associated with sulfonylureas is a special concern for older individuals, especially in those with renal impairment, because these drugs have renal elimination pathways [42]. Other classes of widely used antidiabetic agents include metformin, thiazolidinediones (pioglitazone, rosiglitazone), and meglitinides (nateglinide, repaglinide). For patients



taking any one of these antidiabetic agents, dentists should pay careful attention to any symptoms of hyperglycemia (visual blurring, thirst, urinary frequency) and hypoglycemia (tremor, headache, dizziness) before initiating dental treatment. Reminding patients to take their medications and eat before coming to the dental appointment is important in reducing the occurrence of these events.

Hypothyroidism is another common disorder in the older population and is effectively managed with levothyroxine. Adverse effects of levothyroxine include palpitations, tachycardia, and myocardial infarction in severe cases. Although dental treatment of older patients with hypothyroidism is safe, these patients may be at small risk for myxedema coma during complicated and stressful dental treatment: one of the important risk factors for myxedema coma is advanced age [43]. In addition, potentially dangerous arrhythmias can occur when vasoconstrictors are administered during dental procedures to patients taking thyroid hormone replacement [44].

### **Medications frequently prescribed by dentists**

Several factors complicate the prescription of medications to older patients by dentists. Pharmacokinetic and pharmacodynamic alterations, as described earlier, are one important consideration. Dosage adjustments may be needed to avoid drug toxicity. Other factors dentists need to consider before prescribing medications to elderly patients are multiple disease states, currently prescribed drugs, the potential for therapeutic duplication, and potential adverse effects and drug interactions. All medications frequently prescribed by dentists, including antibiotics, analgesics, anti-inflammatory agents, and sedatives, should be used with caution in older patients to avoid adverse effects and unnecessary complications.

#### *Antibiotics*

Antibiotic classes commonly used in dentistry include penicillins, cephalosporins (eg, cephalexin), macrolides (eg, azithromycin), tetracyclines, metronidazole, and clindamycin. Most antibiotics can be safely used in older patients without dosage reduction; dose adjustment is usually not necessary when a single-dose antibiotic prophylaxis is required before a dental treatment. Penicillins, cephalosporins, and tetracyclines are eliminated through the kidney; hence a dose reduction may be required when a 1- or 2-week course of antibiotic therapy is anticipated in elderly patients with severe renal impairment [45]. Accumulation of penicillins and cephalosporins can cause seizures in severe cases, and tetracycline accumulation can cause liver toxicity. Clindamycin-associated GI problems such as diarrhea and colitis have a higher incidence in older patients [46]. Older patients should be counseled carefully on symptoms of colitis and

instructed about proper management of GI complications when clindamycin is prescribed.

The elderly are especially susceptible to several drug interactions with antibiotics. Antibiotics such as erythromycin, tetracycline, and metronidazole, which can increase the anticoagulant effect of warfarin and cause bleeding, should be avoided when possible. Erythromycin and tetracycline should be avoided in patients taking digoxin, because these drugs can increase the digoxin serum level and lead to digitalis toxicity [47]. Other significant drug interactions of which the dentist should be aware include the potential for erythromycin to increase the serum concentrations of felodipine, possibly leading to hypotension and edema, and the potential of theophylline to cause toxic effects such as tachycardia, arrhythmias, and seizures [48]. A thorough medication history is required to assess the potential for adverse drug interactions with commonly prescribed antibiotics.

### *Analgesics*

Acetaminophen (APAP) usually is the analgesic of choice in older adults, owing to its safety profile compared with other available agents [49]. The recommended maximum daily dose of APAP is 4 g in healthy adults. In older patients, however, APAP dosage generally should be limited to 2 to 3 g per day because of reduced hepatic function in older individuals and the drug's potential for hepatotoxic effects, especially in patients who drink more than two alcoholic beverages a day [32]. When recommending APAP or prescribing an opioid/APAP combination (eg, hydrocodone/APAP [Vicodin]) for pain in older patients, dentists should be aware that patients may be taking other OTC medications containing APAP for other indications (eg, cough and cold preparations) and should ensure that usage of APAP is limited to 3 g per day.

Tramadol is another nonopioid analgesic that can safely and effectively be used for mild to moderate orofacial pain. It often is used in patients in whom NSAIDs are contraindicated. Tramadol is generally considered to have equal efficacy to codeine and hydrocodone [50]. Although tramadol has a mechanism of action similar to that of opioids, common side effects associated with narcotics, such as somnolence and constipation, are reduced with tramadol. The usual daily maximum dose of tramadol is 400 mg, but in elderly patients daily maximum dose should be limited to 200 to 300 mg because of the risk of seizures with drug accumulation, especially in those with renal and hepatic impairment [50,51].

Opioids are used for the short-term management of moderate to severe orofacial pain. Codeine is a weak opioid and may not provide adequate analgesia. The use of propoxyphene should be avoided in the elderly because of its limited efficacy and the risk for neural and cardiac toxicity [10,50,52]. Meperidine also should be avoided in older adults because of the high

potential for CNS side effects, especially in elderly patients with compromised renal function [10,11]. Anxiety, tremor, and seizures can occur with meperidine accumulation, even with short-term usage. Alternative agents, such as hydromorphone and morphine, which are without concerns for accumulation and toxicity in older patients, are preferred. Especially problematic side effects of opioids for older patients are constipation and sedation. Constipation is the most common side effect of narcotics and is especially difficult for older patients who may already be taking other constipation-causing medications (eg, calcium channel blocker). Sedative effects during the short-term use of narcotic analgesics can increase the risk of falls in older patients [50]. Dentists should be aware of possible opioid-associated constipation in older individuals and offer preventive measures when prescribing narcotic analgesics in this population.

### *Anti-inflammatory agents*

For orofacial pain that involves inflammation, NSAIDs are recommended for initial management, because APAP and tramadol do not exert anti-inflammatory effects. The most common side effects associated with NSAIDs are GI adverse effects, including dyspepsia, erosions, and ulcerations. NSAIDs also cause fluid retention and peripheral edema owing to their potential for renal toxicity, although these are not as common as GI side effects. Dentists should use caution when prescribing these agents to elderly patients with CHF and hypertension. Newly available cyclooxygenase (COX-2) inhibitors, such as celecoxib, may be preferred in older patients because of the reduced risk for severe GI adverse events; however, the risk of renal toxicity is equivalent to that of conventional NSAIDs [32]. The need for NSAID use should be thoroughly assessed before prescribing these anti-inflammatory agents to older adults taking warfarin, because of the increased risk of bleeding. Patients taking NSAIDs and anticoagulant medications have a 12-fold greater risk of GI bleeding [53]. In these patients, APAP or tramadol is preferred [54]. A history of PUD or other erosive or ulcerative conditions also requires careful attention before NSAIDs are prescribed in older patients. GI prophylactic agents such as H<sub>2</sub> blockers or PPIs may be indicated in these patients if NSAID therapy is required; the lowest effective dose should be prescribed. Table 4 lists considerations for dentists when prescribing NSAIDs to older patients.

### *Sedatives*

Sedatives commonly used in dental practice include benzodiazepines, barbiturates, and chloral hydrate. Diazepam has a long half-life in the elderly: 80 hours as compared with 20 hours in young adults [55]. This prolonged half-life is due to increased volume of distribution of the drug and

Table 4  
Dental considerations when prescribing NSAIDs in the elderly

Clinical issue	Dental considerations
Adverse drug interactions	NSAIDs can decrease the effects of antihypertensive drugs. ↑ Risk for bleeding with concurrent warfarin therapy Digoxin toxicity may occur with concurrent use.
Concurrent illnesses	Caution in patients with CHF Caution in patients with hypertension Caution in patients with PUD, GERD

causes a greater degree of CNS depression in older patients, increasing the risk for falls and fractures [56]. Other long-acting benzodiazepines that should be avoided in the elderly include flurazepam, chlorthalidopexide, and clonazepam [10]. Lorazepam, oxazepam, and temazepam are less lipid soluble and have a different metabolic fate from diazepam, leading to less accumulation; hence these are recommended for elderly patients. These benzodiazepines are also devoid of drug interactions that can increase the serum drug concentration and the risk for CNS and respiratory depression.

Barbiturates are not recommended in older patients, again because of their prolonged half-life in this population and their potential to cause more side effects than other sedatives [10]. Common side effects of barbiturates in elderly patients include drowsiness, lethargy, and severe CNS depression, which can lead to falls and fractures. Barbiturates are potent inducers of hepatic enzymes involved in metabolism of other drugs, and drug interactions with barbiturates can result in inappropriately low levels of other medications. Warfarin metabolism is significantly increased with concurrent barbiturate therapy, for example, an effect that can decrease the anticoagulant effect of warfarin and lead to increased risk for thromboembolic events.

Choral hydrate is considered a second- or third-line sedative agent in the elderly and should be used only for short periods. Chloral hydrate has a prolonged half-life and a potential for severe CNS depression, especially in patients with renal dysfunction; its use in moderate to severe renal impairment is not recommended [57]. Chloral hydrate is also not recommended for elderly patients with chronic obstructive pulmonary disease, severe cardiac conditions, or GI disease.

*Local anesthetics*

Common local anesthetics used in dentistry are amides—lidocaine, mepivacaine, prilocaine, articaine, and bupivacaine. In general, local anesthetics can be safely used in geriatric patients when an appropriate dose is administered. Because of chronic health problems and age-related reduced hepatic function, blood concentrations of local anesthetics may be higher in elderly patients when the dose is calculated based on what is

acceptable for the average adult. Although adverse drug reactions due to local anesthetics are unlikely after single-dose anesthetic therapy, dentists should proceed with caution, especially when administering combined local anesthetics (eg, lidocaine combined with bupivacaine) to older patients [58]. Local anesthetic toxicity presenting as CNS excitation, convulsions, and respiratory depression has been reported with combination therapy exceeding recommended dosing guidelines [59]. Special care is required in older patients with hepatic disease, because the amides undergo hepatic metabolism. An increased half-life of lidocaine has been demonstrated in individuals aged 65 years or more compared with younger adults [60]. In addition, the inhibition of lidocaine metabolism by potent enzyme inhibitors, such as cimetidine, leads to a prolonged elevation of lidocaine blood concentration in geriatric patients, especially when high doses of lidocaine are used or repeated injections are required for prolonged dental procedures [58]. When using a local anesthetic combined with a vasoconstrictor in older patients, the physician should thoroughly review medical and drug histories to prevent possible adverse events. Epinephrine should be used with caution in hyperthyroid patients, because hypertensive crisis and cardiac arrhythmias are possible; likewise, care should be taken with diabetic patients because of their increased risk for hyperglycemia. Propranolol, a nonselective beta blocker, can lead to serious cardiovascular events when combined with a vasoconstrictor, and heart rate and blood pressure should be monitored in patients taking this drug [61]. No such adverse reactions have been associated with the more commonly used beta blockers metoprolol and atenolol.

### **Avoiding medication-related problems**

Avoiding medication mishaps in elderly patients requires effort in several areas. The first steps are identifying and avoiding the use of medications that present a high risk for adverse reactions and identifying patients who are more likely to experience therapeutic misadventures. The Beers list [10] provides a good overview of medications that should be avoided in older adults. Many of the agents that compose the list are older agents that are not well tolerated, present a high risk for toxicity, and are equivalent or inferior to newer pharmacologic agents. They include long-acting benzodiazepines, meperidine, propoxyphene, and pentazocine. Caution is warranted when reviewing any list of potentially inappropriate medications; drugs not appearing on the list may, in fact, be highly dangerous when used in some individuals.

Certain populations of elderly patients are at greater risk than others for developing MRPs. Nursing facility residents take large numbers of medications, including psychotropic and cardiovascular medications that predispose them to cognitive impairment, falls, and other functional deficits

[62]. A similar pattern exists among older adults living in residential facilities for the elderly [63].

In any environment, patients with multiple diseases are at high risk for MRPs, because of the frequent use of many medications and the likelihood that several practitioners are prescribing them without full knowledge of the patient's concurrent medication use. The risk for medication mishaps can be minimized by incorporating some simple strategies into the office visit routine for geriatric patients:

- Obtain a medication history for older patients. This should include prescription and nonprescription drugs, herbal medications, and dietary supplements. The list should be updated at every visit or at least annually.
- Review the history for medications that may potentially duplicate or antagonize medications prescribed in the dental office. Analgesic agents the patient is taking may be sufficient to treat pain that occurs after a procedure. NSAIDs should be avoided in patients taking warfarin or other agents that affect coagulation. A sedative prescribed by the primary physician may substitute for a preprocedural anxiolytic or sedative.
- Review the medication list for medications that have a negative effect on oral health. Many different medications have anticholinergic activity that may cause dry mouth or affect swallowing. A combination of several of these can lead to significant adverse effects.
- Use the primary care physician to coordinate care. Because the primary physician will probably see the patient most frequently, he or she should be notified if any significant addition is made to a medication regimen.
- Encourage the use of a single pharmacy. Pharmacists maintain patient medication profiles, so the use of a single pharmacy ensures that one location will have a record of all medications being taken by an older patient. When the pharmacist identifies a potential adverse reaction or drug interaction, he or she can contact the appropriate prescribers. The pharmacist can also evaluate and recommend nonprescription products for oral hygiene or therapy or refer the patient back to the dentist, when appropriate.

The care of many older adults is medically complex. Collaboration and communication between the dentist, patient, and other health care providers are essential to maximizing drug therapy outcomes and avoiding medication misadventures.

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